A Geospatial Data Management Framework for Humanitarian Response

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ABSTRACT

The success of humanitarian relief efforts is contingent upon the quality and timeliness of information provided to both the decision making and coordinating functions. Poor or fragmented information can lead to inappropriate decisions or poorly coordinated activities. This research focuses on how the application of spatially aware technologies can allow the information dimension of the challenge to become more effective. This will be achieved through the development of a comprehensive framework for the organization of spatially referenced humanitarian information, and corresponding geospatial data model for practical application in the field. The development of a spatial data framework that is both comprehensive and scalable can unleash the power of GIS for humanitarian data managers, and facilitate the collection and sharing of information between agencies that share similar goals. The research involves the development of a framework based on a literature review of best-practices, which will be refined and tested through interaction with the humanitarian information management community.

Keywords

Humanitarian, relief, response, GIS, geospatial, data model, framework.

INTRODUCTION

The success of humanitarian relief efforts is contingent upon the quality and timeliness of information provided to both the decision making and coordinating functions. Poor or fragmented information can lead to inappropriate decisions or poorly coordinated activities. This research focuses on strengthening humanitarian information management to support and improve coordination and decision making during humanitarian response and relief efforts, consequently eliminating gaps in relief provision and assistance. Humanitarian information management can be operationally defined as a systematic approach to identifying, collecting, analyzing, storing, communicating and sharing data for decision support in humanitarian emergencies. It includes the technological and managerial elements of improving situation awareness at the tactical, operational and strategic decision-making levels of organizations involved in humanitarian assistance. This research seeks to answer if humanitarian information management can be improved by the development and implementation of a comprehensive geospatial data management framework. This framework will be implemented as a GIS data model, which will be critiqued and tested by the International Services Information Management Division of the American Red Cross, and their funded partners. Although there have been calls for, and attempts made at a Humanitarian Data Model, we have yet to see a tested product designed for wider distribution across multiple agencies and organization.

LITERATURE REVIEW

The use of geospatial analysis to assist in critical decision making for disaster response has received much attention in the disaster response literature (Adams, 2006; Kaiser, 2003; Verjee 2005). Though initially quite

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optimistic, later reviews turned critical of the apparent lack of functional products from this much hyped analytical tool (Currion, 2005, 2006; Verjee, 2006, 2007, 2010). These authors found that the principle barriers to the application of geospatial technology stemmed from issues of data collection, data management and data sharing, and not from any major deficiency in the technology itself.

Favorable assessments of GIS's disaster response capacity assume the availability of essential datasets, rarely found in the field. The analytical capabilities of geospatial software are well documented (Kaiser, 2003; Heywood, 2006; Bolsted, 2007; Longley, 2010), but in the absence of consistent and reliable data, the final output is often reduced to a simple cartographic product, whose source data are often outdated by the time of production (Chaperon, 2011; Spivey-Estrada, 2011; Verjee 2006). The quality of GIS output is often described using the familiar axiom "garbage in, garbage out", meaning; the utility and reliability of the end product is directly related to the quality of the original data. The key challenge for the application of GIS in the humanitarian arena lies not with the software and analytical processes themselves, but with the construction of simple coherent databases, based upon solid systematic data collection. This process requires a clear concise assessment tool, whose method of data capture is both intuitive, and, consistent with formats acceptable in GIS. The tools and techniques of geospatial analysis can be used to acquire, model, analyze, display and manage any spatially referenced data, to support advanced decision-making (Verjee, 2007). Unfortunately, in many practical fields, including disaster management, GIS is regarded simply as a cartographic tool, to the exclusion of its other and arguably more important capabilities (Adams, 2006; Verjee, 2006).

Field data collected in the fast paced climate of a response effort is quite often inconsistently reported, unstructured, and lacking basic spatial reference information. In many instances, crucial elements of base data are completely absent (Bradt, 2002; MapAction, 2010; Verjee, 2007). Unfortunately, if needs cannot be quantified in a systematic measurable way, relief cannot be requested with any degree of certainty, and consequently gaps in that relief provision are impossible to determine. This sentiment was echoed in personal correspondence with Colin N. Chaperon, Field Operations Officer with the International Response Operation Center of the American Red Cross (ARC) (Chaperon, 2011). Mr. Colin Chaperon led the American Red Cross Emergency Response Unit as they collected rapid assessment data in the immediate aftermath of the 2010 Haitian earthquake. He indicated that while the ARC maintained formal 24 and 72 hour rapid assessment products, no formal infrastructure or methodology existed for the collection of corresponding geospatial information.

The SPHERE handbook 2004 states how the different and often conflicting assistance approaches of humanitarian agencies remains a major obstacle to data collection and sharing. These differences were credited to several issues, the most prominent being conflicting agency identities and different operational mandates. These problems initiate further issues such as a lack of data sharing, lack of wider data applicability and a duplication of efforts. Assessment efforts are all too often replicated in a disaster setting. This can result from benign reasons such as inconsistent lines of communication or lack of inter-agency contacts, but all too often this issue is a result of agency self-interest. Information is power, and a data rich agency is in a better funding position than one without. Many agencies collect data to fulfill their specific mandate rather than to garner a holistic view of the situation. Although more appropriate measures have been suggested (such as those outlined in the SPHERE handbook, 2004), many agencies prefer to stick to their traditional approach. Darcy and Hofmann 2003 note that much of the data collection by thematic sector within the UN cluster system is performed by NGO's, rather than the leading UN agencies themselves. This often results in a lack of cohesion and leadership in the overall effort, a sentiment echoed in correspondence with American Red Cross Officials (Chaperon, 2011; Spivey-Estrada, 2011).

The first comprehensive attempt at a specific geospatial data model was suggested by MapAction in 2010. Although configured for their own operations, MapAction have made the details of their model available to all in an effort to facilitate information exchange between MapAction and various partners in the field. The authors of this report identify three primary streams of geospatial data in a disaster setting:

a) (Pre-crisis, or pre-deployment) reference datasets composed for generic geographic reference (such as the initiatives indicated above);

b) (Situational Data) the amalgamation of a number of third party data sets and standards for disaster specific situational information

c) (Situational Data) other data which may emerge during an emergency and may prove significant (MapAction, 2010).

The authors see no practical way to merge these three data streams into a logical pre-disaster data model. One assumes this conclusion comes from their significant operational experience in the field. Therefore, MapAction's current approach is to create project-specific databases as required, using *"a predictable and*

proceduralised approach" (MapAction, 2010). MapAction's framework consists of three parts: a data naming convention; a partial in house data model; and a variety of software tools. One of the most important components of this project is standardized naming conventions, conventions which are both human and computer readable; human in that they are concise and logical; computer-readable in that their syntax allows for cataloguing and querying for advanced geospatial functions. Standardization also provides a guide for consistent cataloguing of data collected in the field. The authors of the report claim that "*Standardization of humanitarian assessment templates remains a vision rather than a reality*" (MapAction, 2010), and that the overwhelming lack of consensus on the matter renders the idea of a situational data model for assessment data, difficult, if not impossible. Despite this cautionary advice from an experienced leader in the field, the development and testing of such a model remains the goal of this research.

METHODS

Research Plan

This research seeks to build upon existing knowledge and best-practices. Using a systematic method of identification and prioritization, existing needs assessment tools and literature will be evaluated, and a geospatial framework developed that incorporates critical elements. This research is based on a two-stage sequential exploratory mixed methods approach for instrument design (Creswell & Plano Clark, 2010). The sequential exploratory design process consists of two distinct phases, the qualitative, followed by the quantitative. Each phase will involve data collection, data analysis, instrument development and testing components. The rationale for this approach is that the qualitative data, (assessment tools, handbooks, qualitative surveys from practitioners) will provide substantive materials for instrument development; the geospatial data management framework. The second stage, the quantitative stage will consist of a practitioner evaluation of the revised framework (and associated data model) in order to test hypothesis of this research. The details and sequencing of these phases are outlined below:

Stage 1: Qualitative Analysis:

- The first data collection component will involve a comprehensive review of existing needs assessment and resource tracking products. This will include existing humanitarian needs assessment products, rapid assessments, rapid epidemiological assessments, and public health assessments. Information on key variables, level of detail and appropriate metrics will be recorded. Variables and metrics will be prioritized for inclusion in the first version of the Humanitarian Geospatial Framework (HGF 1.0).
- The first edition of the framework will be published online, as a GIS database schema, in a password controlled environment. (A website devoted to the development and improvement of the framework will be launched as part of the development process). Pre-identified qualified practitioners will be invited to critique and participate in dialog concerning the improvement of HGF 1.0. The initial critical assessment of HGF 1.0 will be conducted by qualitative survey, and additional dialog will be controlled and facilitated by a members-only discussion forum associated with the development site.
- Findings from this research will be coded, and written up as preliminary findings of the developmental process. Information garnered from these findings will be used to modify and/or expand the research methodology. HGF 2.0 will be developed.
- An expert group workshop will be scheduled in conjunction with a major conference. Expert group participants will be asked to participate in an exercise scenario. This exercise will have an analytical GIS component. A qualitative survey will be conducted to evaluate both the new framework and the exercise.
- Information garnered from the evaluation survey will be used to modify the framework, and HGF 3.0 will be developed. An ArcGIS geospatial data model version of HDF 3.0 will be tested by leading humanitarian organization (International Services, Information Management Division of the American Red Cross). The product will be field tested and its efficiency/utility will be determined by quantitative survey.

Stage 2: Quantitative Analysis

- Outcomes from the expert sessions (quantitative surveys), field test (quantitative surveys), and evaluation by independent practitioners (quantitative surveys) will be synthesized to evaluate whether or not

humanitarian information management with the benefit of a comprehensive geospatial data management framework is indeed more efficient. Pending the positive evaluation of the framework and corresponding ArcGIS data model, HGF 4.0 will once again publically posted to encourage further engagement and development.

All survey and exercise elements of this research proposal will require pre-approved by the Internal Review Board (IRB) at The George Washington University (GWU),

CONCLUSION

Research Scope & Potential Expansion of Research

This research proposes a model to focus on the collection of georeferenced data during the rapid assessment phase of a disaster (0-72 hours). Sector specific assessments, and longer term needs such as those encountered during the recovery and rebuilding phase would necessitate an expanded more detailed version of the framework. This framework is intended to be scalable, both spatially and temporally; therefore the metrics and variables identified during this research would form the basis of a more detailed initiative, which I intend to pursue on satisfactory completion of this research.

Concluding Remarks

The effective coordination of international emergency response remains a persistent challenge. Successful coordination is information driven; but in the urgent climate of the response effort, the collection of consistent comprehensive information is difficult, if not impossible (Chaperon, 2011; MapAction, 2010). Without a systematic way to assess, catalog and manage humanitarian needs, relief supplies tend to be insufficient or inappropriate, resulting in gaps in assistance that are hard to resolve. Before geospatial analysis can become a consistently beneficial and reliable tool for responders, a re-design and multi-agency adoption of a standardized assessment product modeled using the object-relational data management structure supported by GIS platforms is necessary. This product should come on the heels of a comprehensive framework that not only assesses spatially referenced needs, but equates resources mobilized to meet those needs.

A positive response to this research and its participatory elements is expected, as its initiation was in response to expressed interest from the humanitarian information management community, specifically the International Services Information Management Division of the American Red Cross.

The systematic and transparent design process is sensitive to the needs of all participants, as the success and adoption of a standardized geospatial framework relies on the inclusion of all major actors. Their participation not only validates this research effort, it enforces reality checks to the design that may not be apparent from the needs assessment literature.

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